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ABSTRACT

The suggestions offered in this paper are based on the experiences of two scientific researchers of how evaluations undertaken in a competitive arena, in which true experimental designs are not viable, can be designed in such a way that meaningful comparative data can be examined. Case studies of the Science and Engineering Research Semester and the Laboratory Graduate Research Participation programs at the Oak Ridge Institute for Science and Education illustrate how one can make use of existing comparison groups when the establishment of control groups for each cohort in an educational study is not economically feasible. Data from national surveys are used for comparative purposes. These surveys include: (1) the Survey of Earned Doctorates of the National Science Foundation (NSF); (2) the Survey of Doctorate Recipients, another NSF survey; (3) the NSF New Entrants Survey; (4) the Survey of Experienced Scientists and Engineers, also an NSF component survey; and (5) the National Survey of College Graduates. Items from these surveys that are clearly relevant are selected for comparisons. In conclusion it is remarked that this approach is not a panacea, and requires thorough understanding and careful evaluation of the national survey, but it can be a useful and cost-effective alternative to traditional control-group designs. Ten figures illustrate survey use. (Contains nine references.) (SLD)

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Using National Surveys to Improve the Efficiency and Effectiveness of Broad-Based Program Evaluations

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Using National Surveys to Improve the Efficiency and Effectiveness of Broad-Based Program Evaluations[1]

Under ideal circumstances--with no budgetary, time, procedural, or personnel constraints--most researchers would choose to employ a true experimental design when conducting program evaluations. Such designs, if properly conceptualized and carefully implemented, allow the researcher to reach defensible conclusions about the existence and extent of programmatic effects. Unfortunately, many situations exist in which the use of a true experimental design is either impossible or impractical. These situations include such factors as ethical constraints (e.g., problems of withholding positive treatments), sampling constraints (e.g., inability to randomly select and/or randomly assign subjects to treatment groups), and the potential contamination of the treatment and control groups.

In the context of assessing the outcomes of national educational programs in a competitive environment (i.e., in which grants or contracts are awarded based on solicited proposals), the considerations are apt to be much more mundane. If a researcher proposed to implement an aggressive, empirically sound, true experimental evaluation design, his/her proposal would probably not be financially competitive with proposals that use less rigorous evaluation designs. The likelihood of its inherent scientific superiority being valued highly enough by the sponsoring agency to warrant its being funded instead of a less expensive, less rigorous alternative, is not at all predictable. Often sponsors are (understandably) more concerned with showing the positive outcomes of a program (so that they can justify its continuation) than they are with determining which of these outcomes may be clearly attributable to the program. Because positive outcomes are often easy to identify and frequently seem to be

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[1]This paper is based on a presentation made at Evaluation '91, the annual meeting of the American Evaluation Association. Work on the present paper was supported, in part, by the American Statistical Association and the National Science Foundation. The paper is based on activities supported by the U.S. Department of Energy, Office of Science Education and Technical Information, and performed by the Oak Ridge Institute for Science and Education (ORISE). Oak Ridge Associated Universities manages and operates ORISE under the U.S. Department of Energy Contract No. DE-AC05-76OR00033. Any opinions, findings and conclusions, or recommendations expressed in this paper are those of the authors and do not necessarily reflect the policies and views of the American Statistical Association, the National Science Foundation, the U.S. Department of Energy, the Oak Ridge Institute for Science and Education, Oak Ridge Associated Universities, or the University of Tennessee.

acceptable indicators of the worth of a program in the eyes of those who fund them, the program sponsors are often reluctant to commit funding to sophisticated evaluation procedures that could otherwise be spent on the program itself.

The extent to which a professional evaluator is willing to develop and undertake a program assessment that is less scientifically rigorous than he/she might like is a highly personal matter, but this issue will not be considered here. The realities of contract evaluation often dictate that compromises be made in "best practice" techniques. This does not mean that competitively-won evaluations are necessarily inferior evaluations. Nor does it mean that program effects cannot be established for evaluations that do not use true experimental designs. The purpose of this paper is to offer suggestions, based on the experiences of the authors, on how evaluations undertaken in a competitive arena in which true experimental designs are not viable can be designed in such a way that meaningful comparative data can be examined. This approach is consistent with Patton's (1982) notion of practical evaluation, and is responsive to his call for generating "a great deal of really useful information with extremely scarce resources" (p.19).

Making Use of Existing Comparison Groups: A Case Study

Context

The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility, which is managed and operated by Oak Ridge Associated Universities, a private, not-for-profit corporation sponsored by 65 colleges and universities. Through its Science/Engineering Education Division, ORISE conducts educational program evaluation and assessment studies for a variety of federal sponsors, including the Department of Energy, the Department of Education, and the National Science Foundation. In general, the objectives of the evaluation and assessment activities include providing quantitative and qualitative measures of the impacts of these programs on participants, assessing programmatic achievements, providing information for the improvement of program operations, and determining the extent to which the programs meet their stated objectives. The educational programs are intended

to enhance some element of the production of scientists and engineers (S/Es) in this country--for example, the recruitment and retention of students to S/E programs of study and S/E careers; the pursuit of graduate S/E degrees; the extent of research involvement by scientists and engineers; or addressing the current underrepresentation of women and minorities in S/E study and S/E careers.

One such program is the Science and Engineering Research Semester (SERS) program, which is sponsored by the Office of Science Education and Technical Information, U.S. Department of Energy (DOE). The SERS program provides research appointments to about 150 U.S. undergraduate students each year at one of six DOE national laboratories. Participants have the opportunity to become involved in "hands-on" research, working with scientific teams engaged in long-range investigations and using state-of-the-art facilities and equipment. SERS research appointments are available in biomedicine, chemistry, materials science, engineering, physics, environmental science, geoscience, mathematics, computer science, artificial intelligence, energy systems, and waste technology. One of the objectives of the SERS program is "to encourage students to seek graduate degrees and research careers in science and engineering disciplines or areas supportive of the DOE mission" (Stevenson et al., 1991, p. 8).

Another such program is the Laboratory Graduate Research Participation (Lab Grad) program. The Lab Grad program is an important component of the University/DOE Laboratory Cooperative Program, which is also supported by the Office of Science Education and Technical Information in DOE. The program enables about 200 graduate students annually to conduct thesis or dissertation research in residence at a DOE facility. Lab Grad participants work with laboratory scientific staff and are able to make use of equipment and facilities that are not generally available on university campuses. Participants' research projects must complement ongoing research at the host facilities and must meet degree requirements for the students' graduate programs. Among the stated objectives for the Lab Grad program are "to encourage graduate students to pursue careers and to continue to work in areas supportive of the DOE mission" (Vivio & Stevenson, 1990, p. 4).

Need for Comparison Groups

The SERS and Lab Grad programs are typical of educational programs for which the authors have been conducting follow-up assessments for several years. The problems inherent in evaluating the extent to which these programs meet general (but clearly primary) objectives such as those above are considerable. The measurement of short-term effects (e.g., pre- and post- research-experience attitudinal comparisons) are of very limited use, as far as determining whether participants will indeed go on to pursue graduate degrees or research careers in science or engineering. Long-term follow-up of former participants is essential to reaching firm conclusions about the attainment of such objectives. The special difficulties in maintaining current addresses for students and early-career graduates are well established. Assuming that some former participants do indeed pursue graduate degrees and/or research careers in science or engineering, it is difficult to attribute those choices to the SERS or Lab Grad programs without some basis for comparison. Identifying, surveying, and following-up a control group of non-SERS or non-Lab-Grad students for each cohort of SERS or Lab Grad participants is economically infeasible for these programs.

Identification of Appropriate Comparison Groups

In order to assess the degree to which programs like SERS or Lab Grad have met these general objectives in the absence of traditional control groups, researchers at ORISE and Argonne National Laboratory have turned to several national data bases containing information on scientists and engineers. In cooperation with the National Science Foundation (NSF) and the National Research Council, questionnaires have been developed in which key items used in the evaluation of the programs being evaluated conform to those used in large national studies sponsored by NSF, DOE, and other federal agencies. Using questions and response options from these national surveys makes it possible to compare program participants to national norms with respect to many relevant variables.

Depending on the objective being assessed and the point in time at which the assessment is made (relative to the completion of participation in the

educational program), items from one or more of the following national surveys (for which NSF is the primary sponsor) are used: (a) the Survey of Earned Doctorates, (b) the Survey of Doctorate Recipients, (c) the Survey of Recent College Graduates (formerly called the Survey of Recent Science, Social Science, and Engineering Graduates--or the New Entrants Survey), and (d) the National Survey of College Graduates (formerly called the National Survey of Natural and Social Scientists and Engineers--or the Survey of Experienced Scientists and Engineers, or the Postcensal Survey). Each of these surveys is described below, based on the data collection procedures used in the 1980s and those presently in use. (The Division of Science Resources Studies at NSF undertook a major restructuring of these data collection efforts for the 1990s, which substantially changed the characteristics of several of the surveys.)

Survey of Earned Doctorates. This survey is conducted annually for NSF by the National Research Council to collect information on the number and characteristics of recipients of doctoral degrees in the United States. The data gathered in this survey are used in the construction of the Doctorate Records File (DRF), which is virtually a census of all recipients of research doctorates (excluding professional or clinical degrees such as the J.D., M.D., and D.V.M.) awarded by U.S. educational institutions since 1920. The DRF contains more than 1,000,000 records, almost 85 percent of which came from the Survey of Earned Doctorates, which has been conducted since 1958. (National Science Foundation [NSF], 1987, pp.15-19; Ries & Thurgood, 1993)

Survey of Doctorate Recipients. The Survey of Doctorate Recipients is one of three NSF surveys that cover various S/E subpopulations. Together, these three surveys comprise NSF's Scientific and Technical Personnel Data System (STPDS). Conducted biennially for NSF by the National Research Council since 1973, the Survey of Doctorate Recipients is designed to provide national estimates of the supply and utilization of science and engineering doctorates. This longitudinal survey is based on a sample drawn from the DRF, and is stratified on several characteristics (such as sex, field of doctorate, and a combination of racial/ethnic identification, handicap status, and nativity). Data are collected for major demographic and employment-related variables. Demographic variables include age, citizenship, marital status, sex, race, and ethnicity. Employment-related variables include employment status, employment

sector, primary work activity, and salary. (Holmstrom, 1988; NSF, 1987, pp. 21-25; Office of Scientific and Engineering Personnel, National Research Council [OSEP/NRC], 1993, pp. 3-9)

The SDR sample size in 1989 was approximately 74,000, which represented about a 1-in-13 sample of S/E doctorates, but the response rate during the five survey cycles in the 1980s deteriorated to 55 percent in 1989. In 1991, the sampling frame was modified somewhat, and the sample size was reduced to about 38,000, so that survey resources could be re-directed to improving the response rate. The improvement in response rate was considerable in 1991--to 80 percent (87 percent, when weighted), which includes data gathered in a CATI effort. (OSEP/NRC, 1993, pp. 3-9)

New Entrants Survey. A component of the STDPS, the objective of this biennial survey is to provide data on the demographic and employment characteristics of individuals who receive bachelor's or master's degrees in S/E fields from U.S. institutions. In the 1980s, this was a cross-sectional mail survey, conducted for NSF by the Institute for Survey Research at Temple University. In the 1990s, the cross-sectional portion of the survey, which is now conducted primarily as a CATI survey, will be carried out by Westat, Inc., and a sample of each graduating class will be added to the National Survey of College Graduates, which is described below.

The survey population is limited to S/E degree recipients who were citizens or permanent resident aliens at the time of their degree award. A two-stage probability sample is used, with the primary sampling unit being universities and colleges, stratified by geographic region, public/private institutional status, type of curriculum offered, proportion of graduates with S/E majors, and two special strata consisting of universities and colleges that have a predominantly black student body or that have high concentrations of Hispanics. The secondary sampling unit consists of graduates drawn from the sample of universities and colleges. Individuals drawn from institutions in the special strata are oversampled in order to increase the reliability of data on racial/ethnic groups. Like the Survey of Doctorate Recipients, data are collected for major demographic and employment-related variables. Demographic variables include age, citizenship, marital status, sex, race, and ethnicity. Early career

employment-related variables include employment status, employment sector, primary work activity, and salary. (Holmstrom, 1988; NSF, 1987, pp. 27-39) The 1993 survey has been expanded to include more extensive information on educational background, educational choices, professional development activities, and parents' education.

The sample size for the 1990 survey, which included the graduating classes of 1988 and 1989, was about 26,000. The 1993 survey, which includes the classes of 1990, 1991, and 1992, has a sample size of approximately 28,000. This represents about a seven percent sample of master's-level S/E degree awards and a four percent sample of bachelor's-level S/E degree awards. (J. Tsapogas, personal communication, September 22, 1993)

Survey of Experienced Scientists and Engineers. An integral component of the STPDS, this biennial longitudinal survey provides data on the number and characteristics of individuals who were identified as being part of the S/E population following the preceding decennial census. The survey is carried out for NSF by the U.S. Bureau of the Census. The original sample of about 138,000 used in the 1980s (i.e., based on the 1980 decennial census) was stratified on the basis of education, occupation, sex, and race. Information was collected on education and training (level and field of degree), demographic characteristics (age, citizenship, marital status, sex, race, handicapped status, and ethnicity), employment status, and employment profile (occupation, type of employer, primary work activity, salary, work experience, etc.). (NSF, 1987, pp. 3-13)

The content of the National Survey of College Graduates, first used in 1993, has been expanded to include more detailed information about respondents' present and former jobs, reasons for changing jobs, training and professional activities, educational background, and parents' education level. The 1990s surveys are based on a sample of about 214,000 from the 1990 decennial census. Eighty percent of these individuals did not report a S/E occupation on the census form, but the initial postcensal survey (which is currently under way) is designed to determine which of these individuals hold S/E degrees. Those that do hold S/E degrees will be included in subsequent survey cycles, along with the roughly 43,000 individuals in the sample who reported an S/E occupation in 1990. This

experienced sample will be supplemented each survey cycle with a sample of bachelor's and master's graduates who received S/E degrees since 1990. This sample will be drawn from the New Entrants Survey. (M. Regets, personal communication, August 1993)

Selection of Items

Only those items from the "parent" surveys that are clearly relevant to the objectives of the program being assessed are selected for inclusion in the instruments for the programs being assessed. These may include general demographic items (e.g., gender, race, citizenship) as well as items that relate to specific program-related characteristics (e.g., academic major, degree level, employment specialty). Demographic differences between the two survey populations (i.e., program participants and NSF survey population) may result in rival hypotheses about program effects, so it is useful to have the same response options for these demographic variables in both instruments if at all possible.

The comparisons to be made from the use of such existing data clearly cannot generate conclusions as definitive as those drawn from a true experimental design. In order to increase the relevance of these comparisons, nevertheless, it is important to minimize the number and severity of uncontrolled influences on the comparisons. The careful selection and construction of items on the new instrument is critical to maintaining the credibility and usefulness of the comparisons.

Figures 1 and 2 are examples of seemingly straightforward demographic items that vary from one survey to another. Because respondents are influenced by the choices they are offered, it is important that the researcher pay attention to the response options used in the data collection instrument from which the comparison group information came. In the case of items for which the characteristics being measured may be related to the expected outcomes of the evaluation (e.g., when rival hypotheses emerge), the evaluator should adopt the same item wording and response options whenever possible. This means that he/she will have to have already identified the comparison group(s) and the desired comparisons when the evaluation instruments are constructed.

Figures 3, 4, and 5 are examples of items from the NSF-sponsored surveys that have been integrated into follow-up assessments of DOE-sponsored programs like SERS and Lab Grad. Although the type-of-employer item (Figure 3) is rather general in nature, it was important to offer the same response options as the national surveys in order to make legitimate comparisons between the DOE participants and broader groups of scientists and engineers. The primary-work-activity item (Figure 4) and the area-of-national-interest item are more specific and are intimately tied to the objectives of DOE-sponsored educational programs.

Designing and Interpreting Comparisons

Once the data are collected from former program participants using items drawn from the NSF questionnaire(s), the precision of the comparisons desired (or the precision that is possible) determines how the comparison data are derived and presented. In some cases, only very general "benchmarks" are needed in order to permit a reader to achieve a reasonable perspective on reported characteristics of program participants. It may not matter that the groups are not strictly comparable. Published data often suffice for this purpose. When more precise comparisons are desired (and both data sets and survey methodologies suggest its appropriateness), special tabulations are requested from the NSF survey contractor or special tabulations are generated by ORISE from a DOE-owned sponsors' data tape.

Benchmark comparisons. Figures 6, 7, and 8 are examples of comparisons drawn from published data and/or special analyses of national data sets that are directly related to the objectives of DOE educational programs. In Figure 6, the primary work activity of Lab Grad respondents is compared to various groups of scientists and engineers. All but one of these comparisons are drawn from published data. One has only to consider the difficulty of interpreting--even in the most general terms--the data from former Lab Grad participants in the absence of the other columns in order to recognize the value of these nonequivalent comparisons. Even though each of the comparison groups are not comparable to the former Lab Grads in at least some respect (e.g., age, degree field, degree level, year surveyed), the distribution of work activities of

these groups are nevertheless instructive in gauging the work activities of the Lab Grads. The comparisons in Figures 7 and 8 likewise provide a valuable backdrop against which the Lab Grads' involvement in federally funded work can be viewed.

More definitive comparisons. The follow-up assessment of former participants in the SERS program provided opportunities for deriving more precise comparisons by using the data tape of the 1988 New Entrants Survey. The 1988 survey includes graduates of the classes of 1985-1986 and 1986-1987. For the purposes of the SERS report, a special tabulation was performed using only those students earning bachelor's degrees in science or engineering fields during the academic year 1986-1987.

Data for the 1988 New Entrants Survey was collected in the spring of 1988, so the 1986-1987 graduates would have been out of school for approximately one year. Likewise most individuals who were SERS participants as juniors in the academic year 1987-1988 and those who were SERS participants as seniors in the academic year 1988-1989 would have been out of school for approximately one year in the fall of 1990 when data were collected for the follow-up assessment. As a result, this comparison, although imperfect, allows one to see how former participants in the SERS program differ from science and engineering students who received their bachelor's degrees at about the same time.

Figure 9 depicts a comparison of the academic status of former SERS participants and 1987 S/E bachelor's degree recipients. Even though some of the SERS participants had not received their undergraduate degrees (meaning that the proportion who ultimately attend graduate school is an underestimate in the figure), the extent to which former SERS participants were pursuing graduate degrees was clearly remarkable compared to the 1987 S/E bachelor's recipients. This tendency is directly relevant to the objectives of the SERS program. Likewise, the undergraduate degree fields of the SERS participants are more consistent with those subsumed under DOE's mission than are those of S/E bachelor's recipients in general (see Figure 10).

Conclusions

The techniques described in this paper clearly do not represent a panacea for evaluation ills. The use of existing data sources for comparison groups is neither helpful nor advisable in many situations. Lifting items from existing instruments is not a substitute for thoughtful instrument development. In cases in which it makes sense to compare program participants to well-defined external populations or to general populations, however, researchers might do well to consider using these techniques in planning their evaluations. To maximize the interpretability of the results, the comparison group--together with the questionnaire(s) that produced the data associated with that group--must be identified and evaluated before assessment instruments are designed. This requires that the researcher not only acquire the instrument but that he/she have a thorough understanding of the methodology (e.g., sampling frame, sample design, survey and analysis techniques, response rate, nonresponse adjustments) of the data collection effort. Once the researcher understands the characteristics of the potential comparison group, he/she must consider the limitations of the design nuances and the content of the items themselves with regard to the validity, robustness, and relevance of any comparisons that might be made. Properly handled, however, the use of existing data for comparison purposes can be a useful and cost-effective alternative to traditional control-group evaluation designs.

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Figure 1. Examples of Variation in Response Options for Demographic Items: Race/Ethnicity

from Survey of Earned Doctorates, 1989-90

9. What is your racial background? (Check only one.)
   - 0 ☐ American Indian or Alaskan Native
   - 1 ☐ Asian or Pacific Islander
   - 2 ☐ Black
   - 3 ☐ White

10. Are you Hispanic? ☐ No ☐ Yes ----> 0 ☐ Mexican American
    1 ☐ Puerto Rican
    2 ☐ Other Hispanic

from 1990 Survey of Natural and Social Science and Engineering Graduates

29. Are you:
   - 1. ☐ American Indian or Alaskan Native
   - 2. ☐ Asian or Pacific Islander
   - 3. ☐ Black
   - 4. ☐ White
   - 5. ☐ Other, PLEASE SPECIFY

from 1990 Information Sheet for Participants in the U.S. Department of Energy Science and Engineering Research Semester Program

3. What is your racial background?
   - 1. ☐ American Indian or Alaskan Native
   - 2. ☐ Asian
   - 3. ☐ Pacific Islander
   - 4. ☐ Black
   - 5. ☐ Caucasian (Not Hispanic)
   - 6. ☐ Hispanic
   - 7. ☐ Other

Figure 1(continued). **Examples of Variation in Response Options for Demographic Items: Race/Ethnicity**

from National Education Longitudinal Study of 1988 (Eighth Grade Questionnaire, NELS:88)

31A. Which best describes you? (MARK ONE)

Asian or Pacific Islander	----> GO TO 31B below
Hispanic, regardless of race	----> GO TO 31C below
Black, not of Hispanic origin	|
White, not of Hispanic origin	|----> SKIP TO Question 32, Page 16
American Indian or Alaskan Native	|

31B. Which of these best categorizes your background? (MARK ONE)

ASIAN OR PACIFIC ISLANDER

Chinese
Filipino
Japanese
Korean
Southeast Asian (Vietnamese, Laotian, Cambodian/Kampuchean, Thai, etc.)
Pacific Islander (Samoan, Guamanian, etc.)
South Asian (Asian Indian, Pakistani, Bangladeshi, Sri Lankan, etc.)
West Asian (Iranian, Afghan, Turkish, etc.)
Middle Eastern (Iraqi, Israeli, Labanese, etc.)
Other Asian

31C. Which of these best categorizes your background? (MARK ONE)

HISPANIC

Mexican, Mexican-American, Chicano
Cuban
Puerto Rican
Other Hispanic

31D. What is your race? (MARK ONE)

Black Hispanic
White Hispanic
Other Hispanic

Figure 2. Examples of Variation in Response Options for Demographic Items: Citizenship

from Survey of Earned Doctorates, 1989-90

7. Citizenship:
   - ☐ United States, native
   - ☐ United States, naturalized

   Non-United States
   - ☐ Permanent Resident of United States (immigrant visa)
   - ☐ Temporary Resident of United States (Non-immigrant visa)

from 1990 Survey of Natural and Social Science and Engineering Graduates

28. Are you:
   1. ☐ U.S. citizen
   2. ☐ U.S. naturalized
   3. ☐ Non-U.S. immigrant (Permanent Resident)
   4. ☐ Non-U.S. citizen, nonimmigrant (Temporary Resident)

from 1989 Information Sheet for Former Participants in the U.S. Department of Energy Laboratory Graduate Thesis Research Program

5. Citizenship
   1. ☐ U.S. Native Born
   2. ☐ U.S. Naturalized
   3. ☐ Permanent Resident Alien
   4. ☐ Non-U.S.

Figure 3. Example of Item Adopted for Use in Focused Follow-Up Assessment: Type of Employer

7. Which category best describes the type of your principal employment OR postdoctoral appointment during FEBRUARY 1989?

0 _____ Self-employed
1 _____ Business or industry
2 _____ Junior college, 2-year college, technical institute
3 _____ Medical school (including university-affiliated hospital or medical center)
4 _____ 4-year college
5 _____ University, other than medical school
6 _____ Elementary, middle, or secondary school system
7 _____ Private foundation
8 _____ Hospital or clinic
9 _____ U.S. military service, active duty, or Commissioned Corps, e.g., USPHS, NOAA
10 _____ U.S. government, civilian employee
11 _____ State government
12 _____ Local or other government, specify _____
13 _____ Nonprofit organization, other than those listed above
14 _____ Other, specify _____

Source: 1989 Survey of Doctoral Scientists and Engineers

Figure 4. Example of Item Adopted for Use in Focused Follow-Up Assessment: Primary Work Activity

12. From the activities listed below, select your primary and secondary work activities for your principal job (as reported in #6), in terms of time devoted during a typical week.

    Enter the appropriate codes (1-16) for each in the specified space.

    _____ Primary activity _____ Secondary activity

    1. _____ Teaching
    2. _____ Basic research (i.e., study directed toward gaining scientific knowledge primarily for its own sake)
    3. _____ Applied research (i.e., study directed toward gaining scientific knowledge in an effort to meet a recognized need)
    4. _____ Development of equipment, products, systems
    5. _____ Design of equipment, processes, models
    6. _____ Management/administration of R&D
    7. _____ Management/administration of educational/other programs
    8. _____ Report and technical writing, editing
    9. _____ Professional service to individuals, clinical diagnosis, psychotherapy
    10. _____ Consulting
    11. _____ Operations-production, maintenance, construction, installation
    12. _____ Quality control, testing, evaluation
    13. _____ Sales, marketing, purchasing, customer and public relations
    14. _____ Statistical work--survey work, forecasting, statistical analysis
    15. _____ Computer applications
    16. _____ Other, specify: _____

Source: 1989 Survey of Doctoral Scientists and Engineers

Figure 5. Example of Item Adopted for Use in Focused Follow-Up Assessment: Area of National Interest

18a. From this list of selected areas of national interest, indicate the ONE area to which you devoted the MOST professional time during a typical week at the job reported in #6.

1 _____ Energy and fuel
2 _____ Health
3 _____ Environment
4 _____ Education
5 _____ National defense
6 _____ Food or agriculture
7 _____ Biotechnology
8 _____ Mineral resources
9 _____ Community development and service
10 _____ Housing (planning, design, construction)
11 _____ Transportation
12 _____ Communications
13 _____ Space
14 _____ None of the above

Source: 1989 Survey of Doctoral Scientists and Engineers

Figure 6. Example of Benchmark Comparison Groups: Primary Work Activity

Primary Work Activity of 1979-1987 Lab Grad Survey Respondents and Other Scientists and Engineers

Activity	*Lab Grad Respon-dents*	*PhD S/Es of Age 30-39*[1]	*All PhD S/Es*[1]	*DOE-Funded PhD S/Es*[2]	*All S/Es*[3]	*Energy-Related S/Es*[4]
Applied Research	19.6%	23.9%	17.2%	31.2%	5.6%	7.3%
Basic Research	26.7%	22.4%	15.1%	21.8%	2.9%	2.6%
Development/Design of Products/Processes	3.5%	5.2%	4.5%	4.0%	18.9%	24.8%
SUBTOTAL -- R&D	*49.8%*	*51.5%*	*36.8%*	*57.0%*	*27.4%*	*34.7%*
Computer Applications	3.9%	3.1%	2.8%	1.4%	10.2%	8.8%
Consulting	8.6%	2.3%	3.3%	5.0%	5.5%	7.4%
Management of Programs or R&D	5.1%	8.8%	16.2%	17.9%	27.7%	19.1%
Professional Services to Individuals	3.9%	10.3%	7.8%	0.2%	1.9%	
Teaching	7.1%	18.8%	26.2%	12.5%	7.7%	1.3%
All Others and No Response	21.6%	5.2%	6.9%	6.0%	19.6%	28.7% [5]
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

NOTES:

[1] *Characteristics of Doctoral Scientists and Engineers in the United States: 1987*, NSF 88-331

[2] ORAU data based on NSF's 1987 Survey of Doctorate Recipients

[3] *U.S. Scientists and Engineers: 1986*, NSF 87-322

[4] *Energy-Related Science and Engineering Personnel Outlook, 1987*; DOE/OR/00033-H1

[5] Includes Professional Services to Individuals

Source: *U.S. Department of Energy Laboratory Graduate Research Participation Program: Profile and Survey of 1979-1987 Participants*, April 1990, pp. 19-20.

Figure 7. Example of Benchmark Comparison Groups: Status of Federal Support

Status of Federal Support for 1979-1987 Lab Grad Survey Respondents and Other Scientists and Engineers

Status of Federal Support	*Lab Grad Respon-dents*	*All PhD S/Es*[1]	*All S/Es*[2]	*Energy-Related PhD S/Es*[3]
Funded	61.9%	43.7%	30.9%	42.2%
Not Funded	31.4%	52.7%	64.2%	56.7%
Not Sure and No Response	6.7%	3.6%	4.9%	1.1%
TOTAL	100.0%	100.0%	100.0%	100.0%

NOTES:

[1] *Characteristics of Doctoral Scientists and Engineers in the United States: 1987*, NSF 88-331

[2] *U.S. Scientists and Engineers: 1986*, NSF 87-322

[3] *Doctoral Scientists and Engineers Working in Energy-Related Activities, 1985*; DOE/ER-0322, May 1987

Source: *U.S. Department of Energy Laboratory Graduate Research Participation Program: Profile and Survey of 1979-1987 Participants*, April 1990, p. 21.

Figure 8. Example of Benchmark Comparison Groups: Federal Funding Source

Federal Funding Source of 1979-1987 Lab Grad Survey Respondents and Other Scientists and Engineers

Source of Federal Funds	*Lab Grad Respondents*	*All PhD S/Es*[1]	*All S/Es*[2]	*Energy-Related PhD S/Es*[4]
Department of Defense	17.1%	23.6%	40.0%	17.4%
Department of Energy	51.3%	13.5%	7.6%	55.1%
Environmental Protection Agency	8.2%	4.3%	3.8%	[5]
National Institutes of Health	11.4%	24.4%	5.9% [3]	[5]
National Science Foundation	10.1%	17.2%	3.1%	11.1%
All Others	31.6%	47.5%	31.6%	49.6% [6]
Uncertain of Support/Don't Know Source Agency	1.3%	6.0%	13.8%	
TOTAL	131.0%	136.5%	105.8%	133.2%

NOTES:

Percentages are the proportion of funded S/Es who receive support from each agency.

Totals add to more than 100% because some individuals are funded by more than one agency.

[1] *Characteristics of Doctoral Scientists and Engineers in the United States: 1987*, NSF 88-331

[2] *U.S. Scientists and Engineers: 1986*, NSF 87-322

[3] Includes all of DHHS

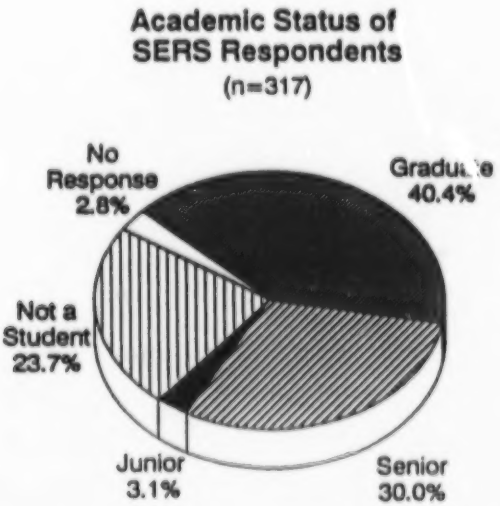
[4] *Doctoral Scientists and Engineers Working in Energy-Related Activities, 1985*; DOE/ER-0322, May 1987

[5] Included in All Others category

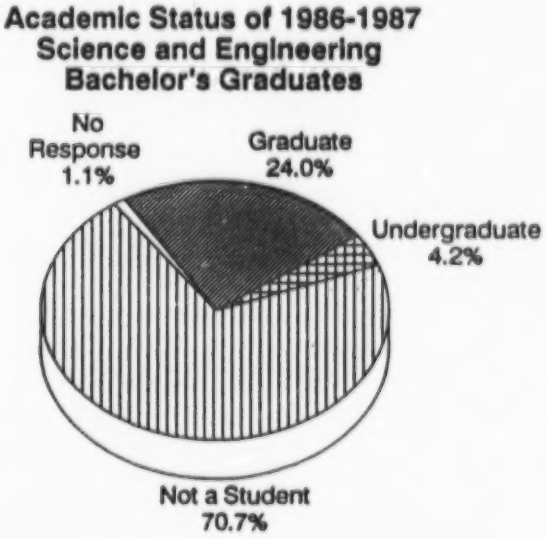
[6] Includes Don't Know Source Agency

Source: *U.S. Department of Energy Laboratory Graduate Research Participation Program: Profile and Survey of 1979-1987 Participants*, April 1990, p. 22.

Figure 9. Example of More Definitive Comparison Groups: Academic Status



Source: SERS follow-up survey of participants during academic year 1987-1988 through Fall 1989.

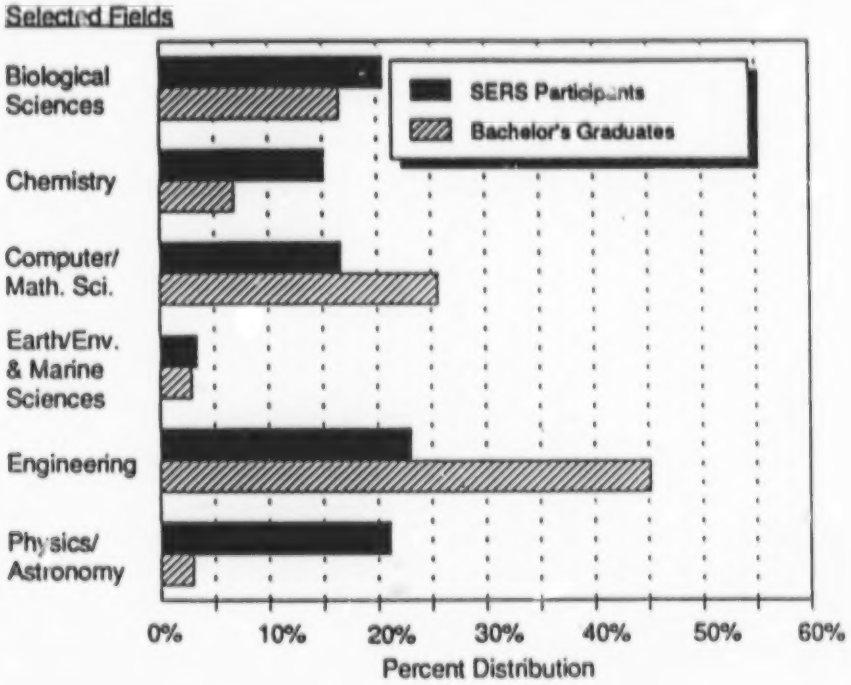


Source: 1988 NSF New Entrants Survey.

Source: *U.S. Department of Energy Science and Engineering Research Semester: Profile and Survey of 1987-1990 SERS Participants*, July 1991, p. 18.

Figure 10. Example of More Definitive Comparison Groups: Undergraduate Majors

Undergraduate Science and Engineering Majors: SERS Participants Versus Bachelor's Graduates



Note: These data have been restricted to include only engineering and physical, biological, and computer/mathematical sciences. The figure represents distribution across these selected fields.

SERS participants include those for academic years 1987-1988 through 1989-1990.

Bachelor's graduates data were from the 1988 New Entrants Survey for those who received degrees in the academic year 1986-1987.

Source: *U.S. Department of Energy Science and Engineering Research Semester: Profile and Survey of 1987-1990 SERS Participants*, July 1991, p. 13.